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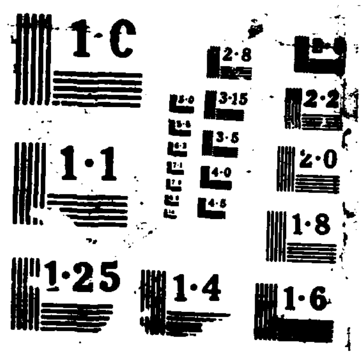
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ACCESS TO MICROGRAVITY: A TECHNICAL DESCRIPTION OF THE NAE T-33 MICROGRAVITY FACILITY

by

J. F. Aitken
National Aeronautical Establishment

AERONAUTICAL NOTE
NAE-AN-47
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OTTAWA
OCTOBER 1987

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ACCESS TO MICROGRAVITY: A TECHNICAL DESCRIPTION OF THE NAE T-33 MICROGRAVITY FACILITY

ACCÈS À LA MICROGRAVITÉ: DESCRIPTION TECHNIQUE DES INSTALLATIONS POUR LES EXPÉRIENCES EN MICROGRAVITÉ À BORD DU T-33 DE L'ÉAN

by/par

J.F. Aitken

National Aeronautical Establishment

AERONAUTICAL NOTE
NAE-AN-47
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OTTAWA
OCTOBER 1987

S.R.M. Sinclair, Head/Chef
Flight Research Laboratory/
Laboratoire de recherche en vol

G.F. Marsters
Director/Directeur

ABSTRACT

The National Aeronautical Establishment operates a T-33 aircraft as a facility for short duration microgravity experiments. Details covering sensors available, experiment electrical and mechanical requirements, package size constraints, power available, and requirements for interfacing experiments with the aircraft instrumentation system are provided for the microgravity experimenter.

RÉSUMÉ

L'Établissement aéronautique national utilise un appareil T-33 comme installation pour effectuer des expériences de courte durée en microgravité. Des détails sur les capteurs disponibles, les exigences au point de vue électrique et mécanique pour les expériences, la puissance disponible et les exigences concernant l'interface entre les expériences et l'instrumentation de l'aéronef sont fournies aux expérimentateurs.

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1.0 INTRODUCTION

The Flight Research Laboratory (FRL) of the National Aeronautical Establishment (NAE) operates a T-33 aircraft which can be used as a microgravity facility. The aircraft is based at Ottawa, Ontario and will be made available to parties interested in performing short duration experiments under near zero gravity conditions. This report gives a description of the aircraft facilities available to the user as well as requirements with which the user will have to comply.

2.0 TEST CONDITIONS

Short periods of near zero gravity conditions can be achieved in an aircraft by approximating a parabolic arc flight path. Duration of the microgravity condition depends upon aircraft speed and pitch angle at the beginning of the arc. With an entry speed of 400 to 420 knots and an initial pitch angle of approximately 45°, a period of 20 to 25 seconds of near zero gravity conditions is possible (Figure 1). Turbulence, aircraft pitch rate, vibrations, control system limitations and limits to the pilot's capabilities in flying a precise parabolic arc all combine to detract from the ideal zero gravity condition, however load factors of ± 0.02 'g' or less, all axes, should be achievable in the NAE T-33. Depending upon user requirements, the parabolic arc manoeuvre can be repeated up to 12 times per flight, each flight lasting about an hour and 15 minutes.

3.0 TEST AIRCRAFT AND EQUIPMENT - GENERAL

The test aircraft is the NAE T-33 C-FSKH (Figure 2). Aircraft dimensions and some performance capabilities are

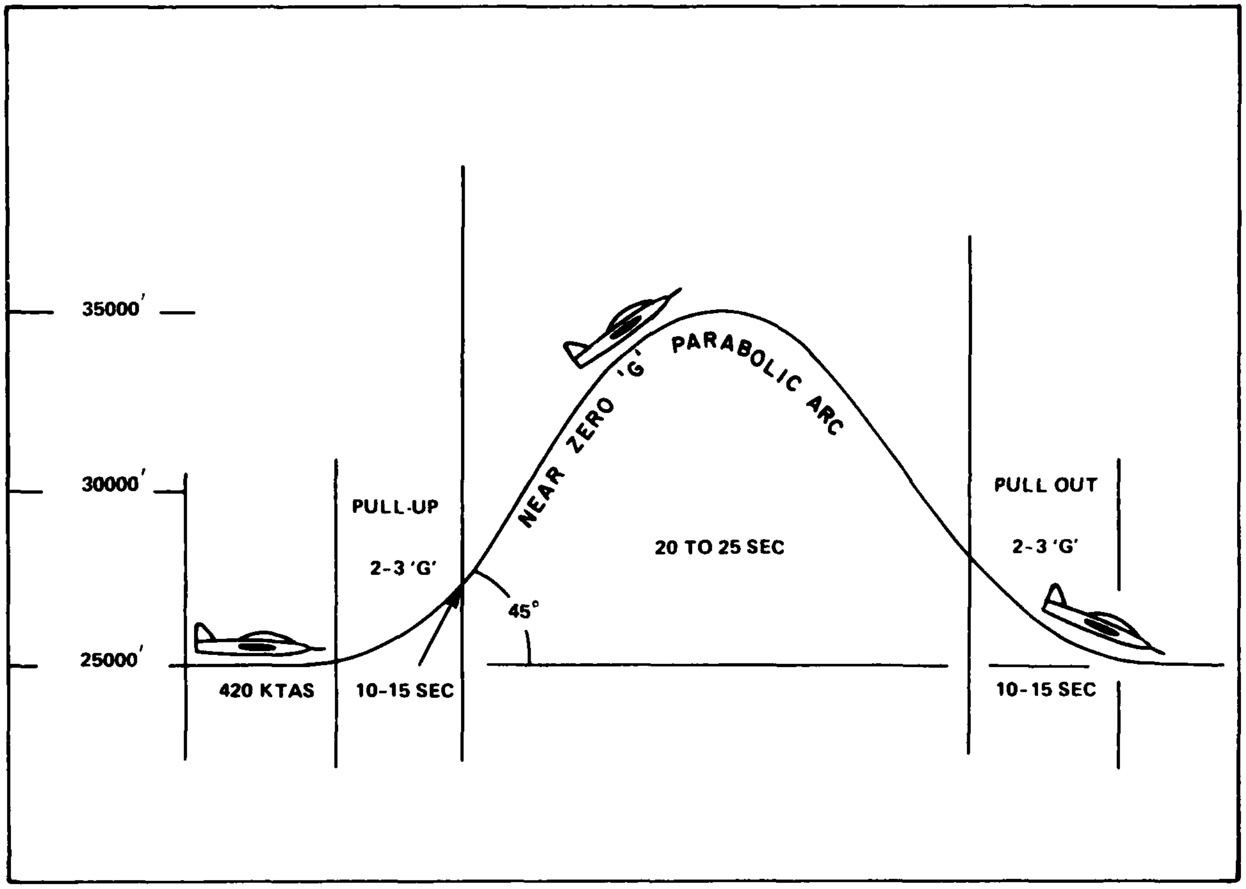


FIG. 1: ZERO "G" FLIGHT PROFILE

FIG. 2: THE NAE T33, C-FSKH

given in Table 1. The aircraft is used for various airborne research applications and is equipped with an instrumentation and recording system. Normally a two seat aircraft, for microgravity flight, the aircraft is converted to a single seat configuration. The rear seat is removed and replaced by a variable height rack (Figure 3) designed to hold standard sized experiment mounting plates.

Table 1
T-33 Dimensions and Performance

Dimensions	
Wingspan	42 ft 5 in
Length	27 ft 9 in
Height	11 ft 8 in
Weight max.	16,800 lb
Performance	
Cruising Speed	.72 MN/415 KTAS @ 35000
Max Allowable Speed	.8 MN/505 KIAS
Vertical Load Factor Limits	+ 7.33 G - 3.0 G

3.1 Rack and Mounting Plates for Experiments

The rear cockpit experiment rack can accommodate up to 4 experiment plates, depending upon equipment height. Mounted on the bottom layer of the rack are relays to control user experiments and a precision 3-axis accelerometer package for accurate measurement of the microgravity environment. Vibration mounts are used to isolate the entire rack from the aircraft. The rack system can support experimental packages weighing up to a total of 200 lb. Total height of the equipment in the experiment rack is limited to 33 inches.

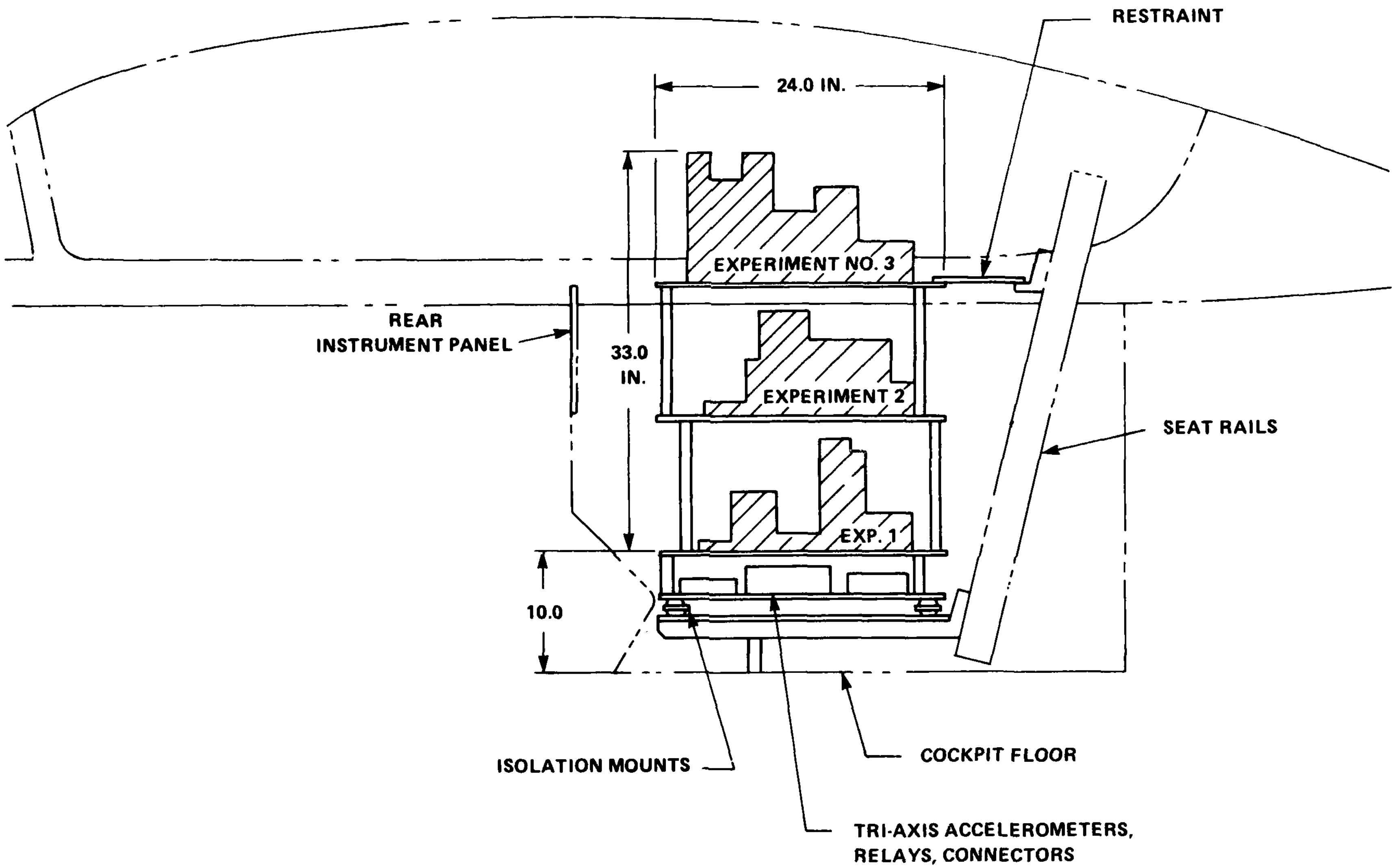


FIG. 3: REAR COCKPIT EXPERIMENT RACK, SHOWING 3-EXPERIMENT OPTION

User experiments are mounted in layers on NAE supplied 18 inch by 24 inch plates (Figure 4). The area at the corners and along the edges of the plates is reserved for securing the plates in the rack. Equipment should not extend beyond the area shown.

3.2 Cockpit Environment

Experimental packages are located in the cockpit and are thus subject to cockpit temperature and pressure variations. Temperature is normally regulated in the 15 to 25°C range, however "greenhouse" effect and winter temperatures can increase this range significantly. Variation of cockpit pressure with aircraft altitude is shown in Figure 5. Aircraft altitude ranges planned for the microgravity parabolas are 6000 to 16000 feet and 25000 to 35000 feet.

3.3 Electrical Power

All aircraft electrical power originates from a 28 volt DC generator. This power is routed directly and through inverters and regulators (Figure 6) to provide the microgravity experimenter with several power options. Power available is given in Table 2.

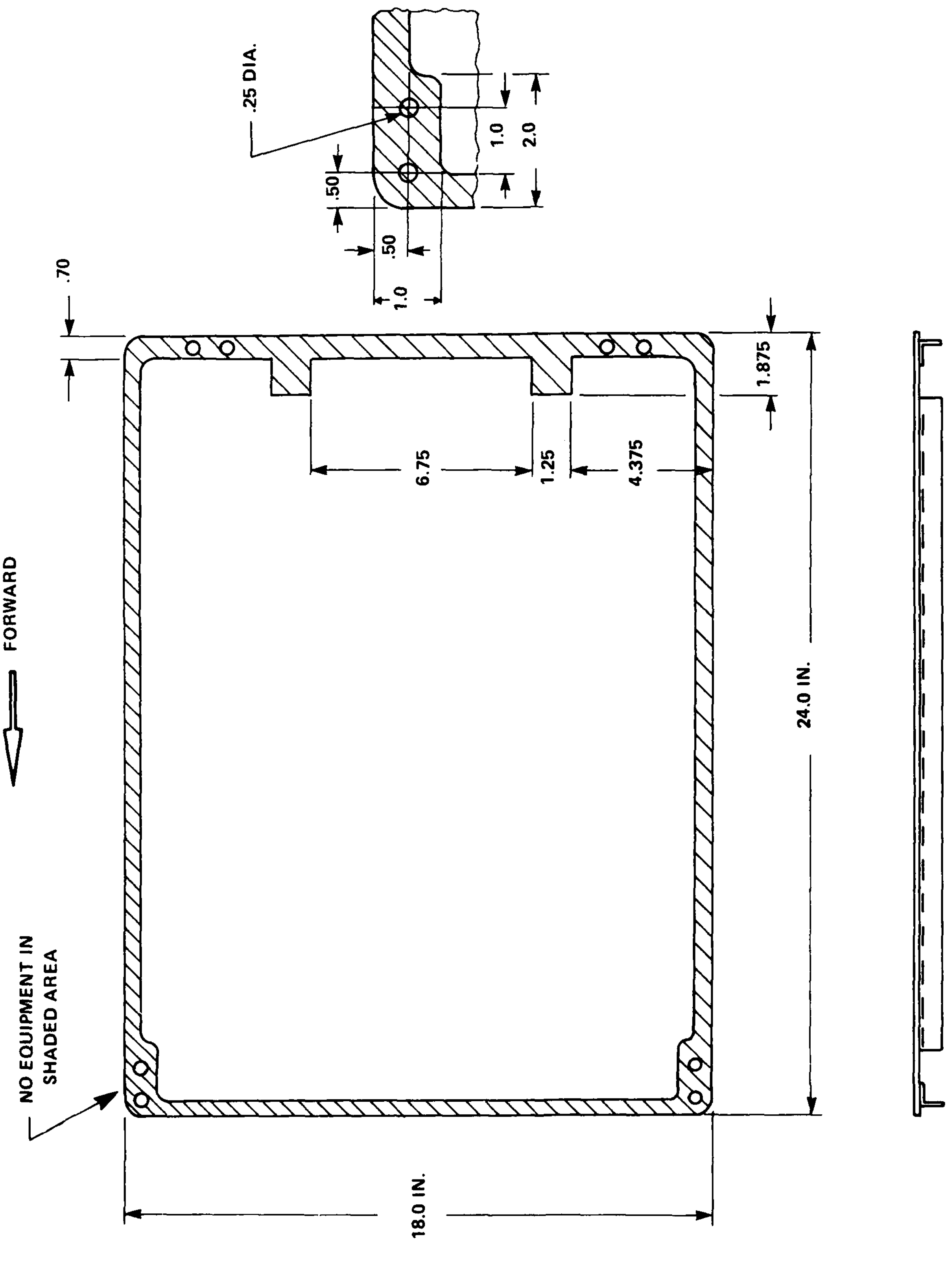


FIG. 4: TEST EQUIPMENT MOUNTING PLATE

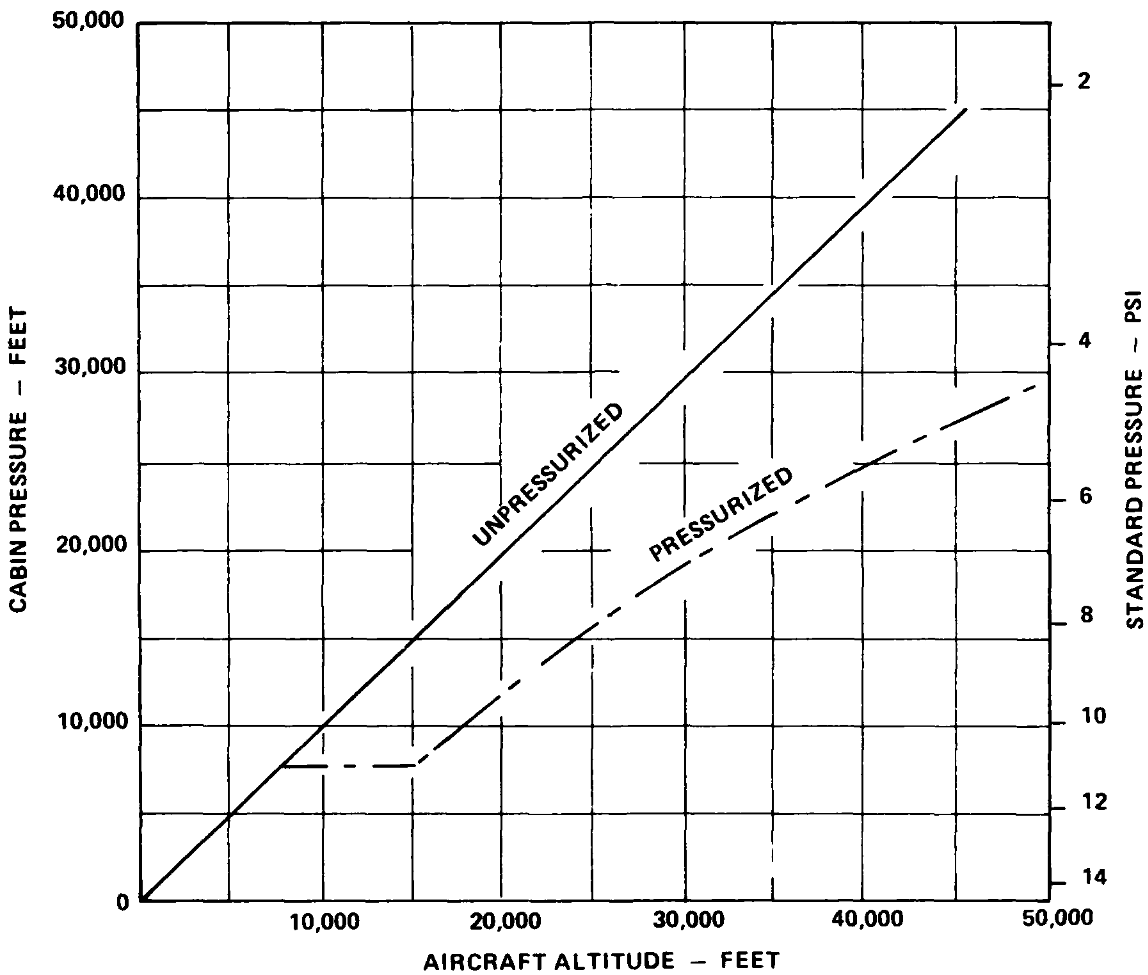


FIG. 5: CABIN PRESSURE VS AIRCRAFT ALTITUDE

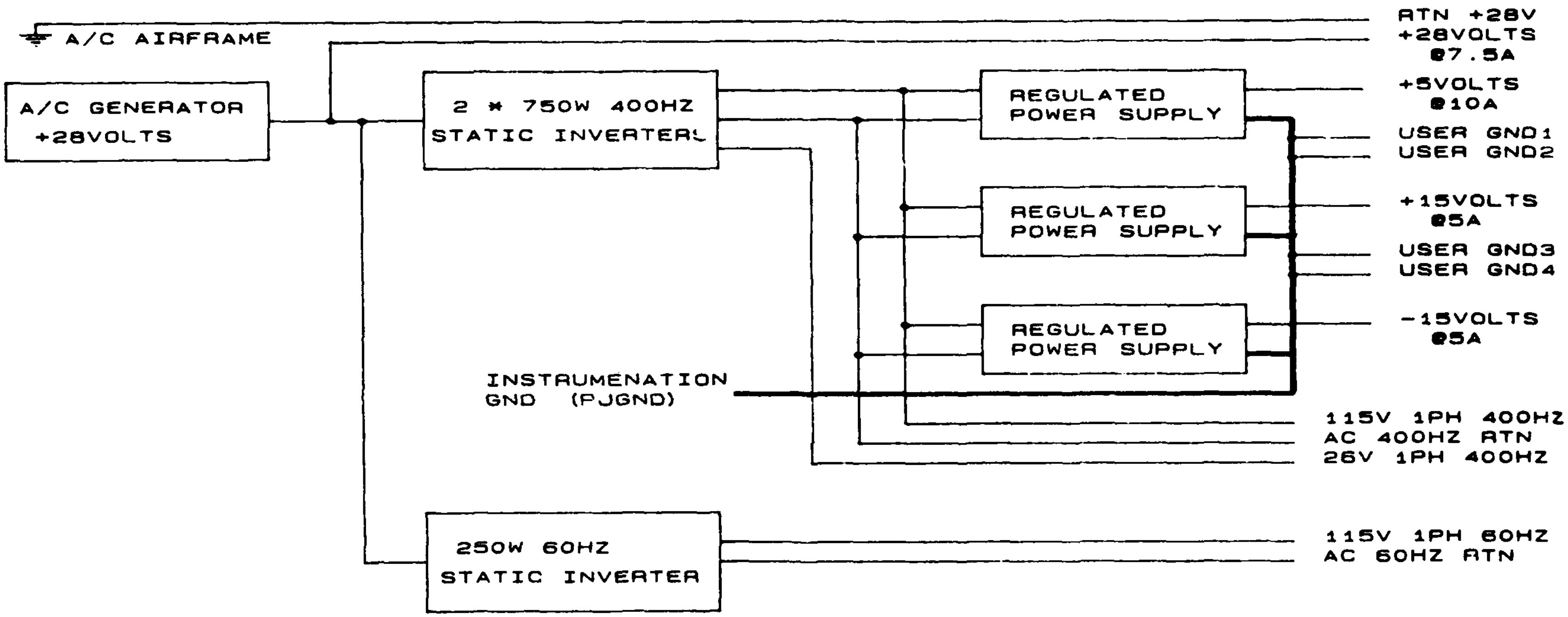


FIG. 6: MICRO-G POWER SOURCE MAP

Table 2
Power Available

Source	Voltage	Frequency	Power
aircraft generator	28	DC	7.5 amps*
400 Hz single phase inverters	115 26	400 Hz 400 Hz	900 va
regulated DC power supplies	+5 ±15	regulated DC regulated DC	5 amps 5 amps
60 Hz single phase inverter	115	60 Hz	250 va

* an additional 45 amps of 28 volt DC is also possible

3.4 Instrumentation System

The aircraft instrumentation system (Figure 7) is based upon a Digital Equipment PDP 11/73 computer, processing and recording 16 bit data words onto a 1/4 inch streaming tape system. Although the system is primarily intended to be operated from the rear cockpit, for the purposes of microgravity experiments, it can be controlled from the front. Front cockpit space constraints limit control and display capability to a computer initialize switch, data record switch, three event level switches, and an LCD 2 line by 16 character alpha numeric display. The display can be used to provide the pilot with limited test parameter information. Pilot interaction with test packages is accomplished through the computer via three event switches. Packages with complex control requirements can be accommodated via software control.

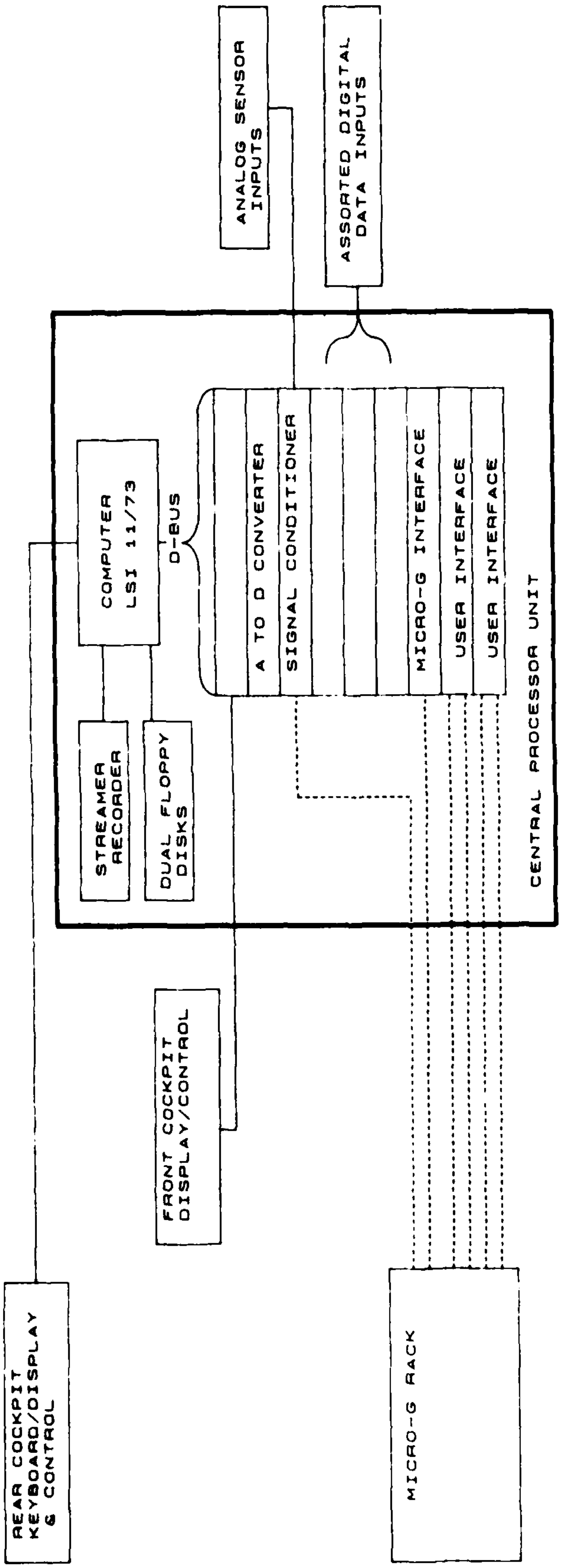


FIG. 7: C-FSKH INSTRUMENTATION SYSTEM

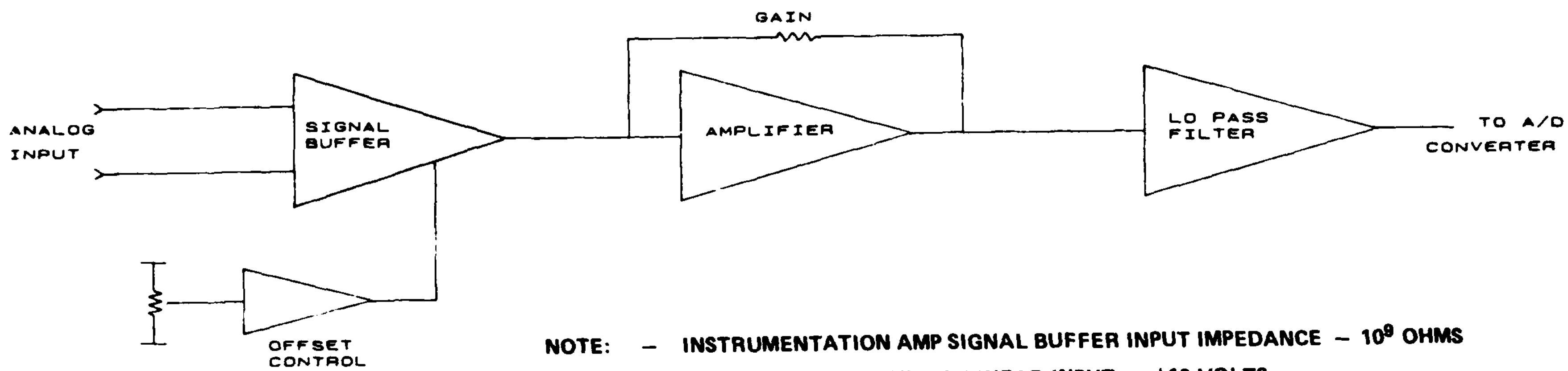
In its standard configuration the instrumentation system can provide a 3 hour (60 Mbyte) digital recording of up to 32 variables at 32 Hz. Analog signals are conditioned (Figure 8) and resolved to 12 bits before recording.

Table 3 lists onboard sensors available for recording. A suggested recording configuration list for microgravity flights would include the first 16 variables plus several user specified status and control variables.

TABLE 3

C-FSKH Sensor List

1.	dynamic pressure	17.	radio altitude
2.	static pressure	18.	Inertial Vx
3.	heading	19.	Inertial Vy
4.	pitch angle	20.	Inertial Vz
5.	roll angle	21.	GNS latitude
6.	pitch rate	22.	GNS longitude
7.	roll rate	23.	throttle position
8.	yaw rate	24.	engine RPM
9.	airframe ax	25.	elevator position
10.	airframe ay	26.	aileron position
11.	airframe az	27.	rudder position
12.	micro 'g' ax	28.	angle of attack
13.	micro 'g' ay	29.	angle of sideslip
14.	micro 'g' az	30.	localizer deviation
15.	time	31.	glide slope deviation
16.	event	32.	total temperature



NOTE: – INSTRUMENTATION AMP SIGNAL BUFFER INPUT IMPEDANCE – 10^9 OHMS

– MAXIMUM DIFFERENTIAL LINEAR INPUT – ±10 VOLTS

FIG. 8: ANALOG SIGNAL CONDITIONING CIRCUIT

Airframe and microgravity (experiment rack) accelerometers, sensors numbered 9 to 14 in Table 3, have the ranges, accuracies and resolutions shown in Table 4.

Table 4
Accelerometer Characteristics

	Recorded Range (g)	**Accuracy** (g)	**Resolution** (g)
airframe ax	±2	±.002	.001
airframe ay	±2	±.002	.001
airframe az	±6	±.006	.003
micro 'g' ax	±1	±.001	.0005
micro 'g' ay	±1	±.001	.0005
micro 'g' az	±1	±.001	.0005

4.0 MICROGRAVITY EXPERIMENT INTERFACING

Electrical connections from the central processor unit (CPU) to the base of the experiment rack are made via a 60 conductor cable. As shown in Figure 9, 24 lines are assigned for control, power supply and rack acceleration signals. The remaining 36 lines are available for experiments. These lines may be used for recording experiment variables, supplying extra electrical power, or for providing extra control capability.

Up to 4 user experiments can be controlled using 4 double pole double throw 10 amp relays mounted at the base of the rack. Wired as shown in Figure 10, these relays can provide on-off control for two functions (for example: warm-up and activate) for each of 4 experiments. Relays are controlled through system software by selecting event

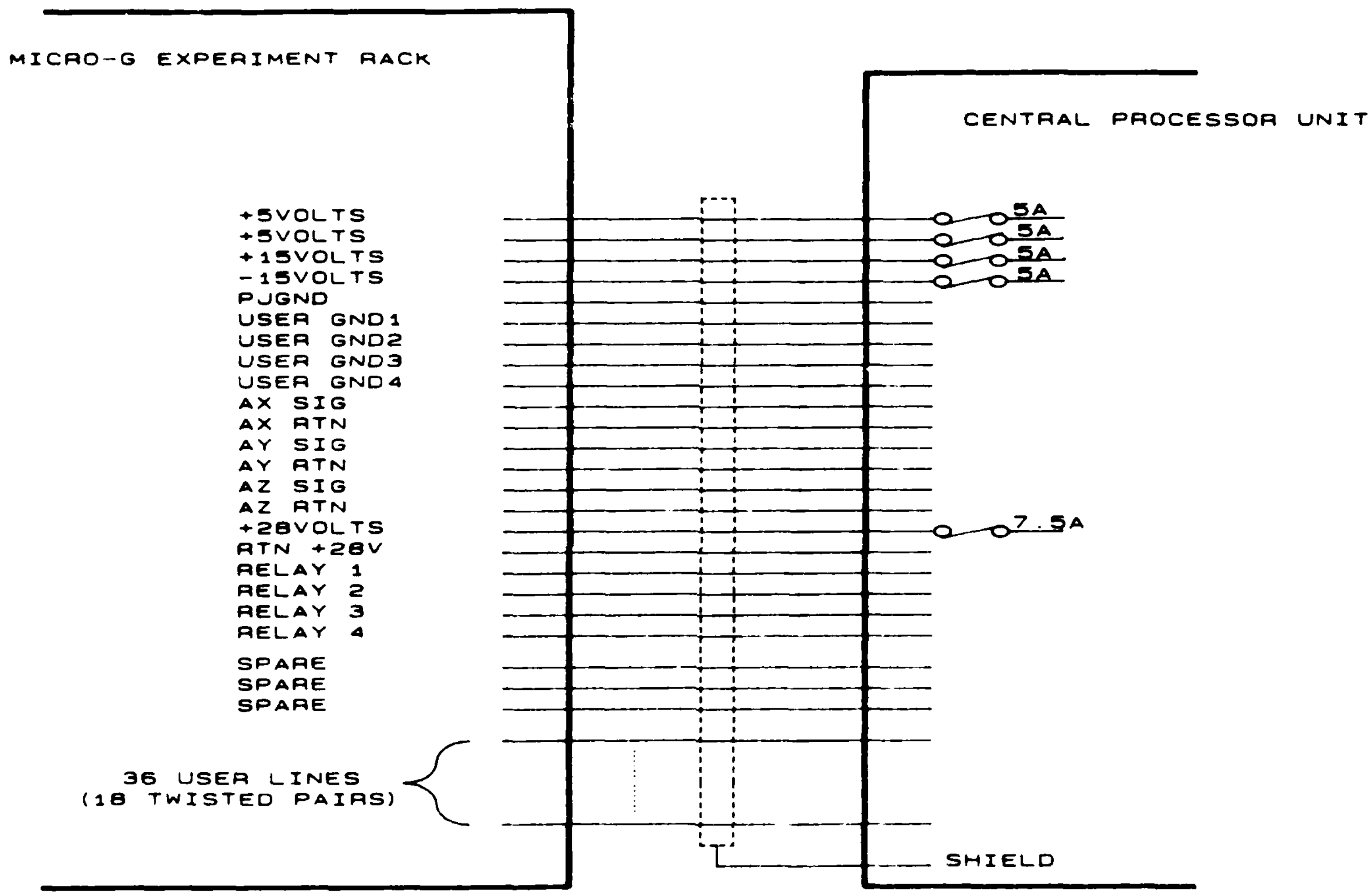


FIG. 9: MICRO-G RACK/INSTRUMENTATION SYSTEM INTERCONNECT

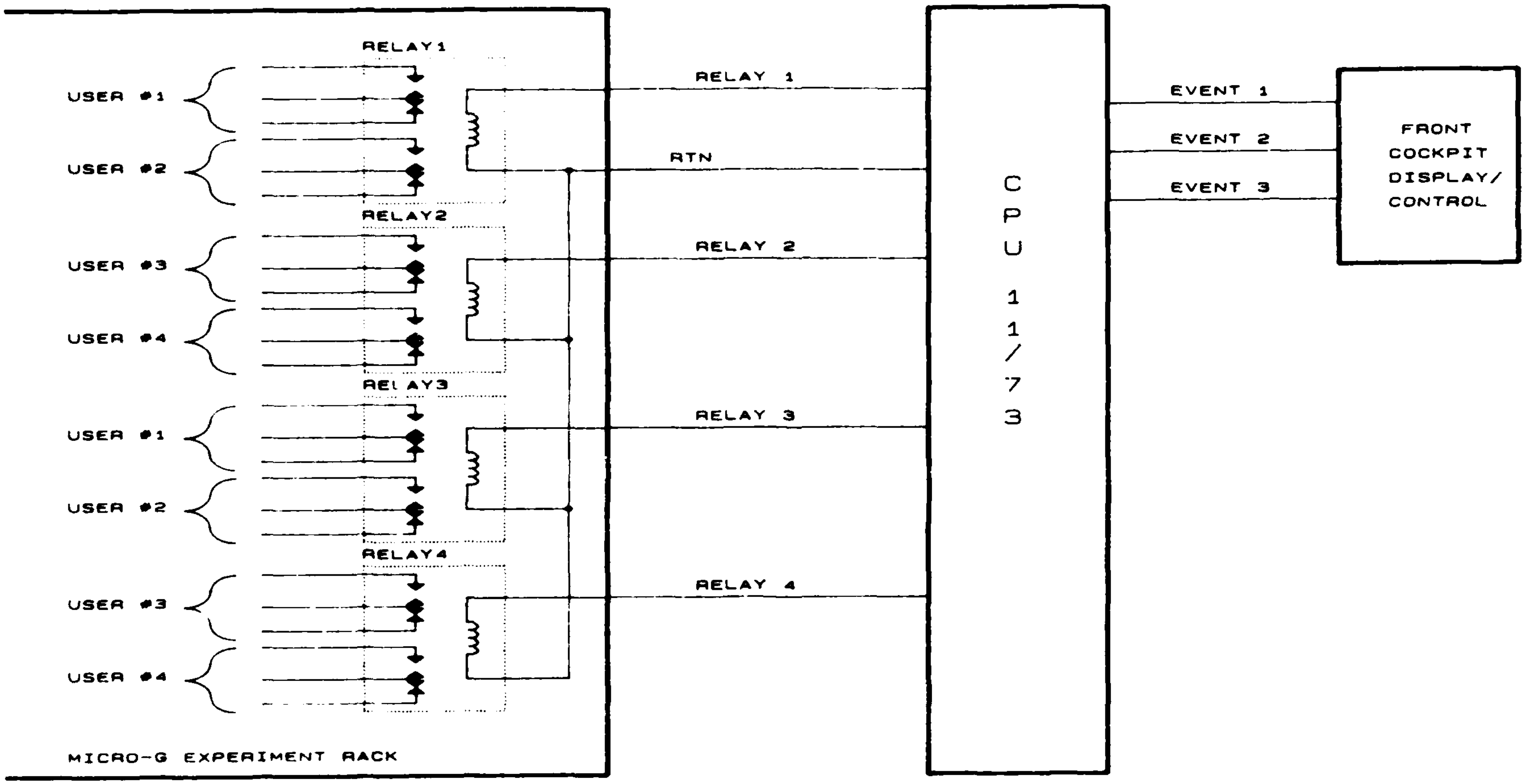


FIG. 10: MICRO-G CONTROL RELAYS

switches on the pilot's control panel. Other control options are possible. Actual control configuration will require direct discussion between the users and the FRL.

In order to simplify connecting individual experiments and to accommodate up to 4 experiments simultaneously, four 26 pin connectors are located at the base of the experiment rack. Each connector supplies one of 4 users with separate power, ground and relay lines plus 9 user option lines (Figure 11). Equipment should be wired to a terminal strip mounted on the experiment plate. A cable connecting the experiment terminal strip to the rack connector will be provided by the Flight Research Laboratory. Complex experiments may require more than one connection.

In all cases where electrical power is used, all experiment return lines (grounds) must be isolated from the rack and the airframe since the instrumentation system operates on a floating ground principle.

Serial RS 232 format communication via standard port interfaces is employed in the aircraft instrumentation system, promoting ease of communication and control with similarly formatted microgravity experiment processors. For complex experiments, user specific interfacing can be developed on NAE designed D-Bus boards (Figure 12). Features available are:

(a) 16 bit data interfacing with host computer;
(b) prioritized/nested interrupt;
(c) TTL level Rubidium frequency standard of 10 MHz; and
(d) +5V and $\pm$15V power rails.

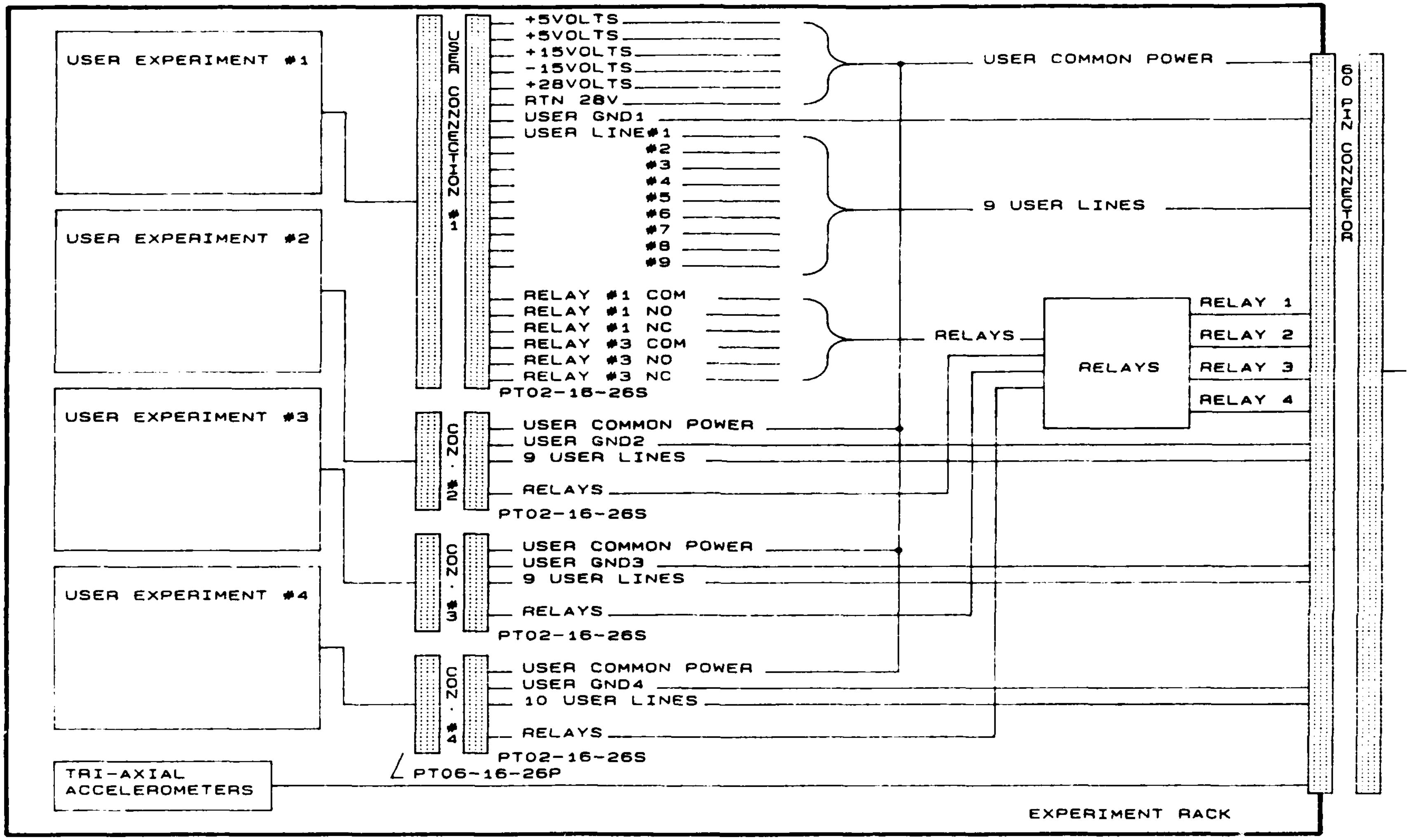
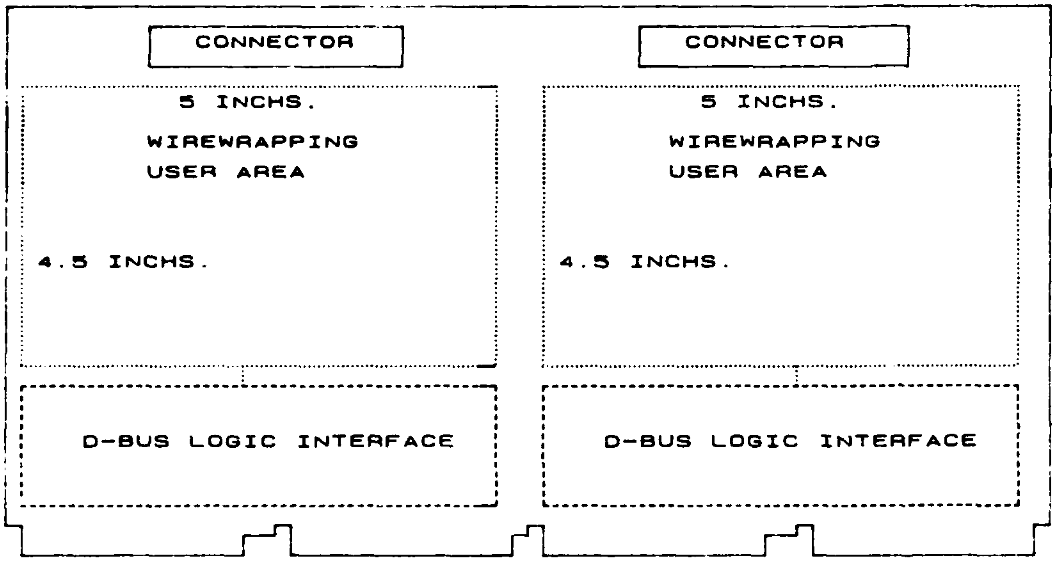


FIG. 11: MICRO-G USER EXPERIMENT ELECTRICAL CONNECTION



2 50PIN BERG CONNECTORS
USER AREA- INTERPOSED POWER AND
GROUND BUSES.
PLATED THROUGH HOLES OF
0.035 INCH DIA. ON 0.1 INCH GRID.
ACCEPTS DIP IC DEVICES OF VARYING
WIDTHS.
+5V AND +/-15V AVAILABLE.
BOARD COMPONENT HEIGHT LIMITED
TO LESS THAN 0.375 INCH.

FIG. 12: NAE D-BUS INTERFACE PROTOTYPING BOARD

5.0 POST FLIGHT DOCUMENTATION

The FRL will supply the user with a data package documenting the conditions encountered and recorded during the experiment. Format and medium of such documentation will be agreed upon in discussions with the FRL.

6.0 MECHANICAL AND ELECTRICAL DESIGN REQUIREMENTS

In addition to requirements covered above, which should ensure compatibility with the aircraft instrumentation system and the space available, user equipment must comply with the requirements laid down in NAE Laboratory Memoranda FR-63(c) and FR-63(e) (Appendices I & II). These memoranda deal with general mechanical and electrical design requirements and with various environmental, vibration and power input tests which experimental equipment is subjected to prior to being flown on NAE aircraft. Note in particular the Crash Landing load factor requirements for equipment mounted in the T-33 provided in FR-63(c) Table 2.

If pressurized equipment is used in an experiment, individual components will be subject to close scrutiny. Specification/certification details for all high pressure components, for example - pressure vessels, valves, hoses, tubing, fittings, etc. - will be required.

7.0 TOXIC MATERIALS

Toxic or hazardous materials will not normally be allowed since the FRL has very limited capabilities in handling such materials and since experiment packages are located in the same small air volume as the pilot.

Exceptions may be possible where it can be demonstrated either because of the small amounts of material involved, or due to exceptional containment properties of the equipment involved that no hazard exists to the pilot or to other FRL personnel in handling and operating the equipment. **It is the responsibility of the user to clearly identify to the FRL any possibly toxic or hazardous materials being considered for use in microgravity experiments.**

8.0 SAFETY REVIEW

All experimental equipment and procedures must undergo and pass a FRL safety review prior to flight. In addition to the experimental equipment itself, the user should provide as a minimum the following information for the safety review:

(a) test plan detailing test objectives and requirements;

(b) test equipment installation and operation procedures or checklists;

(c) test equipment structural analysis to include, if applicable, pressure system description and pressure vessel certification;

(d) test equipment electrical load analysis; and

(e) hazard identification.

9.0 CONCLUDING REMARKS

This report has attempted to cover features, capabilities and limitations of the NAE T-33 Microgravity Facility. Prospective users are encouraged to interact directly with the FRL in the planning stages of their experiments in order to best utilize the extensive capabilities and options available.

APPENDIX I

FRL Laboratory Memorandum FR-63(c)

NATIONAL AERONAUTICAL ESTABLISHMENT NO. FR-63(c)

LABORATORY MEMORANDUM PAGE ...... OF ......

FLIGHT RESEARCH LABORATORY

DESIGN REQUIREMENTS FOR THE MOUNTING OF EQUIPMENT
IN
FLIGHT RESEARCH AIRCRAFT

PREPARED BY: B. Usher
April 1967

APPROVED BY: Dr. S.R.M. Sinclair,
Head,
Flight Research Laboratory

Reissued: May 1982

The following is to be used as a guide in designing and calculating the strength of equipment installations in Flight Research aircraft when more specific data for a particular aircraft is not available and should be used in conjunction with Lab. Memo FR-63(a).

DEFINITIONS

(a) Limit Load - is the maximum load to be expected in service. Limit load deflections shall not prevent safe operation or result in permanent deformation.

(b) Ultimate Load - is a limit load multiplied by an appropriate factor of safety, which shall not be less than 1.5.

(c) Limit Load Factor - is the ratio of the limit load to the weight of the equipment.

(d) Ultimate Load Factor - for crash landing is the ratio of the ultimate crash load to the weight of the equipment.

(e) Factor of Safety - is a design factor used to provide for the possibility of loads greater than those anticipated in normal conditions of operation, and for uncertainties in design, i.e. may include a fitting factor, bearing factor, etc.

1. NORMAL FLIGHT REQUIREMENTS

1.1 Equipment to withstand normal flight and landing loads, which if torn loose from its fastenings during a crash landing, will not injure personnel, block escape hatches, etc., is to be installed on the strength basis considering all six of the forces acting separately as shown in Table I multiplied by a 1.5 structural factor of safety, to obtain the ultimate load factors.

TABLE I

LIMIT LOAD FACTORS FOR NORMAL FLIGHT AND LANDING

Type of Aircraft	Down	Up	Forward	Aft.	Lateral	Ref.
Convair 580	3.41	1.41	1.0	1.25	1.25	Convair EO
Beech 18	3.36	1.35	1.25	1.5	1.5	FAR 23
Twin Otter	3.36	1.35	1.25	1.5	1.5	FAR 23
Harvard	6.0	3.0	1.5	2.25	2.25	FAR 23
T-33	7.33	3.7	2.0	3.0	3.0	RCAF EO
Bell Helicopter 47 Series	3.5	1.0	See note (c) below			FAR 27
Bell 205	3.5	1.0		"		FAR 29
Jet Ranger	3.5	1.0		"		FAR 27

NOTE:

(a) The load factors in Table I are to be taken as acting separately and are absolute values.

(b) Forward, aft and lateral load factors in Table I reference RCAF engineering Report #10.

(c) Forward, aft and lateral load factors for the four helicopters are taken to be the same as those quoted for the Beech 18.

2 CRASH LANDING REQUIREMENTS

The equipment listed below must be installed in a strong enough manner to withstand crash landing or ditching, and must meet those ultimate load factors laid down in Table II, as well as those in Table I.

2.1 All seats and safety harnesses.

2.2 Any equipment, including ballast weights, which if it came adrift during a crash landing or ditching, may cause injury to any crew member or person on board, or prevent the use of emergency exits or emergency equipment (first aid kits, axes, etc.)

TABLE II

ULTIMATE LOAD FACTORS FOR CRASH LANDING

Type of Aircraft	Down	Up	Forward	Aft.	Lateral	Ref.
Convair 580	4.5	2.0	9.0	-	1.5	FAR 25
Beech 18	4.5	3.0	9.0	-	1.5	FAR 23
Twin Otter	4.5	3.0	9.0	-	1.5	FAR 23
Harvard	4.5	4.5	9.0	-	1.5	FAR 23
T-33	10.0	4.5	20.0	-	4.0	MIL-A-8865
Bell Helicopter 47 Series	4.0	1.5	4.0	-	2.0	FAR 27
Bell 205	4.0	1.5	4.0	-	2.0	FAR 29
Jet Range	4.0	1.5	4.0	-	2.0	FAR 27

NOTE:

(a) The load factors in Table II are to be taken as acting separately.

APPENDIX II

FRL Laboratory Memorandum FR-63(e)

L.O.	NATIONAL AERONAUTICAL ESTABLISHMENT	NO FR-63(e)
FILE	OTTAWA, CANADA	PAGE 1 OF 8
PREPARED BY DFD & BU	LABORATORY MEMORANDUM	COPY NO
CHECKED BY SRMS	SECTION Flight Research Laboratory	DATE 31 Jan. 1986

SECURITY CLASSIFICATION **OPEN**

SUBJECT **ACCEPTANCE TESTING AND INSPECTION OF EXPERIMENTAL EQUIPMENT INTENDED FOR USE ON NAE AIRCRAFT**

PREPARED BY **D.F. Daw and B. Usher**

ISSUED TO **All Staff**

Approved by: **Dr. S.R.M. Sinclair**
31 January, 1986

Dates Issued: **22 March, 1985**
18 June, 1985
18 October, 1985
31 January, 1986

ACCEPTANCE TESTING AND INSPECTION OF EXPERIMENTAL EQUIPMENT INTENDED FOR USE ON NAE AIRCRAFT

1.0 Introduction

Equipment intended for use in or on research aircraft operated by the Flight Research Laboratory of the NAE will be subjected to inspection and testing prior to being accepted for installation. This inspection and testing are required to ensure that the operation of the equipment will in no way compromise the safety of flight.

2.0 Equipment Subjected to the Inspection and Testing

This inspection and testing procedure will apply to all equipment intended to be flown in or on NAE aircraft other than the equipment handled by Aircraft Stores and covered by FR-63(d) "Aircraft Stores Procedures". This includes:

2.1 All pieces of equipment supplied by agencies for whom the Flight Research Laboratory is providing flying time or services.

2.2 All pieces of commercial equipment not built and tested to MIL or equivalent civil specifications.

2.3 Any equipment manufactured "in house" by the Flight Research Laboratories and not covered by FR-63(a) "Airworthiness and Flight Safety Procedures".

3.0 Details of the Inspection and Testing

3.1 Mechanical Considerations

Equipment will be inspected for mechanical suitability to insure that:

3.1.1 The structure of the equipment is of strength sufficient to support itself and all the internal components with the appropriate Limit Load Factors as detailed in Table 1 applied.

3.1.2 Sheet metal screws have not been used.

3.1.3 All nuts are locknut type (lockwashers are not adequate), either nylon insert or all metal.

3.1.4 Screws and bolts protrude through nuts.

3.1.5 Where blind screws or bolts are used, they must be wirelocked in place or used with loctite on assembly.

3.1.6 Chassis are not greater than $17^1/_2$ inches in width in order to fit into standard 19 inch racks.

3.1.7 Large, horizontal P.C. boards have been avoided, but if necessary, are supported to prevent flexing of boards.

3.1.8 All internal components, plugs, capacitors, circuit boards, etc. are held in place to prevent them from coming loose during system installation and during aircraft flight. It is not adequate to rely on the wiring to physically support the components.

3.2 Electrical Considerations

The internal electrical wiring will be inspected to ensure that:

3.2.1 MS connectors are used on all the power input and power output connections on the chassis and at the terminations of all cables used for supplying power to the equipment.

3.2.2 All power inputs to the equipment are fused adequately to safely protect the unit and cabling in the event of an internal fault. Further fuse protection is required for major electronic subsystems and for all power wiring that exits from the main unit.

3.2.3 Teflon covered wire of the appropriate size should be used to interconnect plugs, circuit boards, switches, lights, etc. At all terminations heat shrink sleeving should be used. Where possible the wire should be laid in wire runs and mechanically supported.

3.3 Environmental Testing

Equipment will be subjected to environmental testing to cover the range of altitude and temperature consistent with the flight envelope of the aircraft for which the equipment is intended.

3.4 Vibration Testing

The equipment will be vibration tested to MIL-E-5400P specification or to those sections of the specification deemed reasonable for the intended use of the equipment.

3.5 Power Input Testing

The equipment will be tested for variations in power input as per MIL-STD-704C or to those sections of the specification deemed reasonable for the intended use of the equipment.

4.0 The Inspecting Authority

The Inspection of incoming equipment will be carried out by the following personnel:

1. The Senior Instrumentation Technician assigned to the project in question.

2. A Design Officer as appointed from the Design Group.

3. Consultants from other groups within the Flight Research Laboratory, if required.

Each member of the Inspection Team will initial and date the appropriate box on the Incoming Acceptance Tag indicating that the piece of equipment has met the required specifications.

5.0 The NAE Flight Research Incoming Acceptance Tag

Each piece of incoming equipment will be assigned an Incoming Acceptance Tag by the project technician or end user (project engineer or project manager).

This tag will be attached to the piece of equipment and completed as the piece of equipment proceeds through the inspection and testing procedure. This tag will eventually be removed and retained with the appropriate Aircraft Work Order (see paragraph 7.10).

An example of the Incoming Acceptance Tag is shown in Figure 1.

6.0 Failure to Pass the Inspection or Testing

In the event that the piece of equipment fails either the testing or inspection, the Incoming Acceptance Tag will be marked to suitably indicate this failure. The project engineer, project manager or their designate will return the equipment to the client with a list of the short-comings.

Re-worked equipment will be re-submitted for acceptance inspection and testing but may be considered as a new case.

7.0 Procedure to be Followed on Receipt of Equipment Intended for Use on NAE Aircraft

7.1 An Incoming Acceptance Tag will be attached to each piece of equipment by the project technician or end user (project engineer or project manager). The project technician will then have the responsibility of ensuring that the procedures of this section are followed.

7.2 The equipment will be handed over to the project technician who will:

7.2.1 Check for adequate documentation.

(All equipment arriving at the Flight Research Laboratory and intended for flight should arrive complete with a full set of documentation. This documentation should include theory of operation, an operational directive, technical manual (including schematics and power requirements), and a maintenance manual. Current calibration data are also required, where applicable.)

7.2.2 Check for obvious electrical short-comings.

7.2.3 Check for maintainability and serviceability.

(All units should have detachable plugs (MS or similar) at the back of all chassis to facilitate the simple removal of the chassis from the aircraft. A second set of test cables similar to the system on the aircraft should be available to allow bench test and trouble shooting of the system.)

Deficiencies in any of the above three items will be reported to the head of the Instrument Group who will decide on a course of action.

7.3 The project technician will then give the equipment to the technician in charge of environmental testing to perform the required tests. Either the head of the Instrument Group or the Project Engineer/Manager will specify the environmental testing required.

7.4 The technician in charge of environmental testing will perform the required tests and complete the appropriate section of the Incoming Acceptance Tag.

7.5 The project technician will then be responsible for requesting the inspections to be carried out by the Inspection Team.

7.6 The Inspection Team will inspect the equipment to ensure that the operation of the equipment will in no way compromise the safety of flight and then complete their sections of the Incoming Acceptance Tag. If the equipment is considered to be unsafe to operate in a Flight Research Laboratory aircraft the short-comings, faults, deficiencies, etc. will be listed on the reverse side of the Incoming Acceptance Tag or on a separate sheet if necessary.

7.7 The Inspection Team members will notify their respective group heads of any work necessary to upgrade the equipment and the group heads will decide whether or not to undertake the work within the Flight Research Laboratory facilities. The group heads will notify the project manager/engineer of their decision.

7.8 The project technician will supply copies of the completed Incoming Acceptance Tag to the head of the mechanical group.

7.9 The project technician, who is responsible for the equipment, will retain the equipment until it is required for design work or installation.

7.10 At the time the equipment is handed over to the mechanical group for design work or installation the Incoming Acceptance Tag will be removed from the equipment and given to the head of the instrument group for retention in a comprehensive file of completed Incoming Acceptance Tags.

TABLE I

LIMIT LOAD FACTORS FOR NORMAL FLIGHT AND LANDING

Type of Aircraft	Down	Up	Forward	Aft.	Lateral	Ref.
Convair 580	3.41	1.41	1.0	1.25	1.25	Convair EO
Beech 18	3.36	1.35	1.25	1.5	1.5	FAR 23
Twin Otter	3.36	1.35	1.25	1.5	1.5	FAR 23
Harvard	6.0	3.0	1.5	2.25	2.25	FAR 23
T-33	7.33	3.7	2.0	3.0	3.0	RCAF EO
Bell Helicopter 47 Series	3.5	1.0	See note (c) below			FAR 27
Bell 205	3.5	1.0		"		FAR 29
Jet Ranger	3.5	1.0		"		FAR 27

NOTE:

(a) The load factors in Table I are to be taken as acting separately and are absolute values.

(b) Forward, aft and lateral load factors in Table I reference RCAF engineering Report no. 10.

(c) Forward, aft and lateral load factors for the four helicopters are taken to be the same as those quoted for the Beech 18.

NAE FLIGHT RESEARCH INCOMING ACCEPTANCE TAG			
DESCRIPTION			
MODEL NUMBER		AIRCRAFT	
SERIAL NUMBER		DATE RECEIVED	

ENVIRONMENTAL TESTING				INSPECTION		
	RANGE	SIGNED	DATE	GROUP	SIGNED	DATE
VIBRATION				MECHANICAL		
TEMPERATURE				INSTRUMENT		
ALTITUDE						
POWER INPUT						

FIGURE 1

REPORT DOCUMENTATION PAGE / PAGE DE DOCUMENTATION DE RAPPORT

REPORT/RAPPORT	REPORT/RAPPORT
NAE-AN-47	NRC No. 28342
1a	1b

REPORT SECURITY CLASSIFICATION CLASSIFICATION DE SÉCURITÉ DE RAPPORT	DISTRIBUTION (LIMITATIONS)
UNCLASSIFIED	UNLIMITED
2	3

TITLE/SUBTITLE/TITRE/SOUS-TITRE

Access to Microgravity: A Technical Description of the NAE T-33 Microgravity Facility

4

AUTHOR(S)/AUTEUR(S)

J.F. Aitken

5

SERIES/SÉRIE

Aeronautical Note

6

CORPORATE AUTHOR/PERFORMING AGENCY/AUTEUR D'ENTREPRISE/AGENCE D'EXÉCUTION

7

SPONSORING AGENCY/AGENCE DE SUBVENTION

National Research Council Canada

8 National Aeronautical Establishment / Flight Research Laboratory

DATE	FILE/DOSSIER	LAB. ORDER COMMANDE DU LAB.	PAGES	FIGS/DIAGRAMMES
October 1987			45	12
9	10	11	12a	12b

NOTES

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DESCRIPTORS (KEY WORDS)/MOTS-CLÉS

1. Training aircraft (T-33) — microgravity experiments
2. Microgravity — test facilities
3. Reduced gravity — test facilities

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SUMMARY/SOMMAIRE

The National Aeronautical Establishment operates a T-33 aircraft as a facility for short duration microgravity experiments. Details covering sensors available, experiment electrical and mechanical requirements, package size constraints, power available, and requirements for interfacing experiments with aircraft instrumentation system are provided for the microgravity experimenter.

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